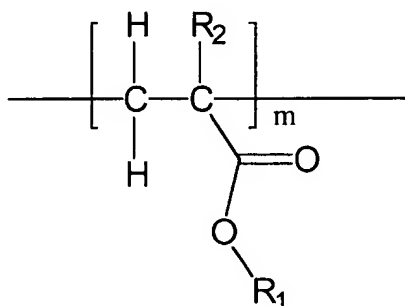


**WHAT IS CLAIMED IS:**

1. A method of forming an underlayer of a bi-layer resist film, comprising:

forming a blended material by blending a polymer having an aromatic group and a methacrylate polymer represented by the following chemical formula:



wherein, R<sub>1</sub> is one selected from a group consisting of an aromatic compound, a hydrocarbon of 1 to 10 carbon atoms, an aliphatic hydrocarbon of 1 to 15 carbon atoms, an alcohol of 1 to 15 carbon atoms, a lactone of 1 to 15 carbon atoms, an ether of 1 to 15 carbon atoms and a carboxylic acid of 1 to 15 carbon atoms, R<sub>2</sub> is a hydrogen or a methyl group, and m is an integer ranging from 10 to 500;

coating a substrate with the blended material; and

irradiating the blended material coated on the substrate.

2. The method according to claim 1, wherein the polymer having an aromatic group is a novolac polymer or a naphthalene polymer.

3. The method according to claim 2, wherein the methacrylate polymer is blended to 20 to 70 wt% of a sum of weights of the novolac and the methacrylate polymers.

5 4. The method according to claim 2, wherein the methacrylate polymer is blended to 20 to 70 wt% of a sum of weights of the naphthalene and the methacrylate polymers.

10 5. The method according to claim 1, wherein the blended material further includes:

at least one selected from a group consisting of a thermal acid generator, a cross-linker and a surfactant.

15 6. The method according to claims 1, wherein the coated substrate is irradiated with UV rays or an e-beam.

7. The method according to claim 6, wherein the UV rays have a wavelength of about 150 nm to about 180 nm.

20 8. The method according to claim 7, wherein the UV rays have a wavelength of about 172 nm.

9. The method according to claim 6, wherein the UV rays have energy of about  $0.1 \text{ J/cm}^2$  to about  $100 \text{ J/cm}^2$ .

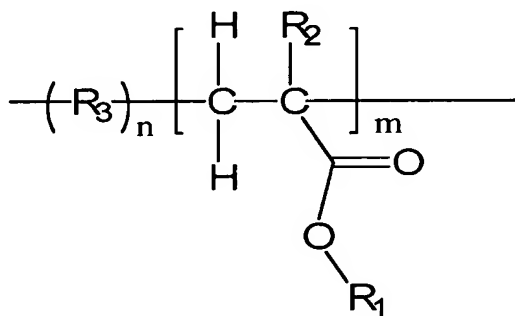
10. The method according to claim 6, wherein the e-beam has energy of about  $0.1 \text{ mC/cm}^2$  to about  $100 \text{ mC/cm}^2$ .

11. The method according to claims 1, wherein the coated substrate is irradiated at a temperature of about room temperature to about  $100^\circ\text{C}$ .

12. The method according to claim 11, wherein the temperature at which the coated substrate is irradiated is adjusted using a hot plate or a halogen lamp.

13. A method of forming a underlayer of a bi-layer resist film, comprising:

preparing a material including a copolymer having a monomer with an aromatic group and a methacrylate monomer, the copolymer represented by the following chemical formula:

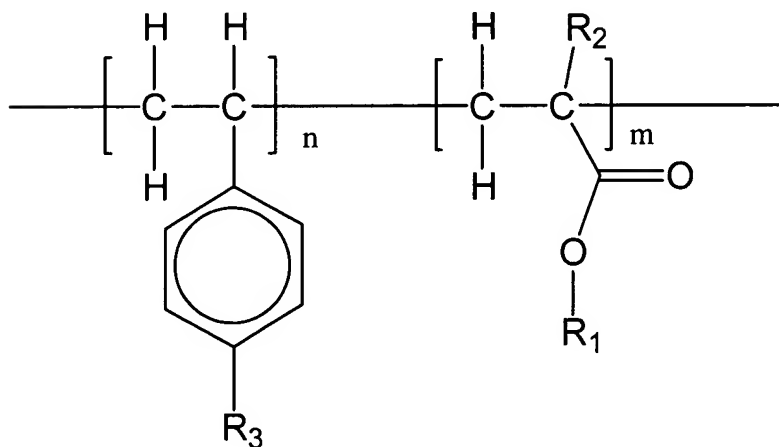


wherein,  $R_1$  is one selected from a group consisting of an aromatic compound, a hydrocarbon of 1 to 10 carbon atoms, an aliphatic hydrocarbon of 1 to 15 carbon atoms, an alcohol of 1 to 15 carbon atoms, a lactone of 1 to 15 carbon atoms, an ether of 1 to 15 carbon atoms and a carboxylic acid of 1 to 15 carbon atoms,  $R_2$  is a hydrogen or a methyl group,  $R_3$  is a monomer having an aromatic group, and each of  $m$  and  $n$  is an integer ranging from 10 to 500;

coating a substrate with the prepared material; and

irradiating the prepared material coated on the substrate.

14. The method according to claim 13, wherein the copolymer is a copolymer having styrene and methacrylate monomers, the copolymer represented by the following chemical formula:



wherein,  $R_1$  is one selected from a group consisting of an aromatic compound, a hydrocarbon of 1 to 10 carbon atoms, an aliphatic hydrocarbon of 1 to 15 carbon atoms, an alcohol of 1 to 15 carbon atoms, a lactone of 1 to 15 carbon atoms, an ether of 1 to 15 carbon atoms and a carboxylic acid of 1 to 15 carbon atoms,  $R_2$

is a hydrogen or a methyl group,  $R_3$  is one selected from a group consisting of hydrogen, a hydroxyl group, a chlorine and a bromine, and each of  $m$  and  $n$  is an integer ranging from 10 to 500.

5                    15.     The method according to claim 14, wherein the mole ratio  $m/(m + n)$  is about 0.3 to about 0.6.

                  16.     The method according to claim 13, wherein the material including the copolymer further includes:

10                    at least one selected from a group consisting of a thermal acid generator, a cross-linker and a surfactant.

                  17.     The method according to one of claims 13, wherein the coated substrate is irradiated with UV rays or an e-beam.

15                    18.     The method according to claim 17, wherein the UV rays have a wavelength of about 150 nm to about 180 nm.

                  19.     The method according to claim 18, wherein the UV rays have a  
20                    wavelength of about 172 nm.

                  20.     The method according to claim 17, wherein the UV rays have energy of about  $0.1 \text{ J/cm}^2$  to about  $100 \text{ J/cm}^2$ .

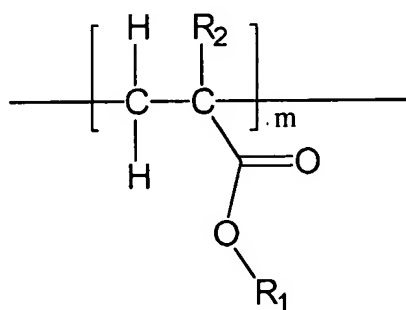
21. The method according to claim 17, wherein the e-beam has energy of about 0.1 mC/cm<sup>2</sup> to about 100 mC/cm<sup>2</sup>.

22. The method according to claim 13, wherein the irradiation of coated substrate is performed at a temperature of about room temp. to about 100 °C.

23. The method according to claim 22, wherein the temperature at which the coated substrate is irradiated is adjusted using a hot plate or a halogen lamp.

24. A method of forming a semiconductor device using a bi-layer resist, comprising:

forming a blended material by blending a polymer having an aromatic group and a methacrylate polymer represented by the following chemical formula:



wherein, R<sub>1</sub> is one selected from a group consisting of an aromatic compound, a hydrocarbon of 1 to 10 carbon atoms, an aliphatic hydrocarbon of 1 to 15 carbon atoms, an alcohol of 1 to 15 carbon atoms, a lactone of 1 to 15

carbon atoms, an ether of 1 to 15 carbon atoms and a carboxylic acid of 1 to 15 carbon atoms,  $R_2$  is a hydrogen or a methyl group, and m is an integer ranging from 10 to 500;

coating a substrate with the blended material;

5 forming an underlayer by irradiating the blended material coated on the substrate;

forming a toplayer over the underlayer;

forming a toplayer pattern in the toplayer;

10 forming an underlayer pattern by etching the underlayer using the toplayer pattern as an etch mask; and

etching the substrate using the underlayer pattern as an etch mask.

25. The method of claim 24, further comprising:

15 performing a first prebake after coating the substrate with the blended material.

26. The method of claim 25, further comprising:

performing a second prebake after forming a toplayer over the underlayer.

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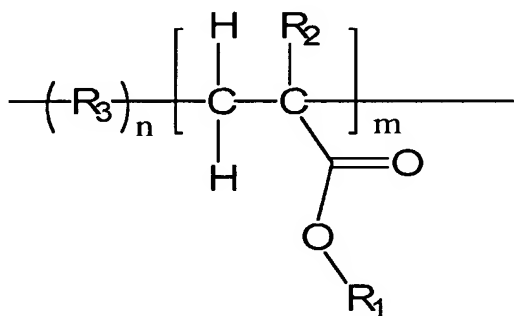
27. The method of claim 24, further comprising:

removing the toplayer and the underlayer after etching the substrate.

28. The method of claim 27, wherein the toplayer and the underlayer are removed by ashing.

29. A method of forming a semiconductor device using a bi-layer resist, comprising:

preparing a material including a copolymer having a monomer with an aromatic group and a methacrylate monomer, the copolymer represented by the following chemical formula:



wherein, R<sub>1</sub> is one selected from a group consisting of an aromatic compound, a hydrocarbon of 1 to 10 carbon atoms, an aliphatic hydrocarbon of 1 to 15 carbon atoms, an alcohol of 1 to 15 carbon atoms, a lactone of 1 to 15 carbon atoms, an ether of 1 to 15 carbon atoms and a carboxylic acid of 1 to 15 carbon atoms, R<sub>2</sub> is a hydrogen or a methyl group, R<sub>3</sub> is a monomer having an aromatic group, and each of m and n is an integer ranging from 10 to 500;

coating a substrate with the prepared material;

forming an underlayer by irradiating the prepared material coated on the substrate;

forming a toplayer over the underlayer;

forming a toplayer pattern in the toplayer;



forming an underlayer pattern by etching the underlayer using the toplayer pattern as an etch mask; and

etching the substrate using the underlayer pattern as an etch mask.

5           30.     The method of claim 29, further comprising:  
performing a first prebake after coating the substrate with the prepared material.

10           31.     The method of claim 30, further comprising:  
performing a second prebake after forming a toplayer over the underlayer.

            32.     The method of claim 29, further comprising:  
removing the toplayer and the underlayer after etching the substrate.

15           33.     The method of claim 32, wherein the toplayer and the underlayer are removed by ashing.